(Jour. Anat. and Phys., January, 1881) gives the result of an examination of the bones, articulations and muscles of the rudimentary hind-limb of the Greenland right whale. Ten sets of these parts were dissected. The synovial capsule of the knee-joint, the acetabular cartilage, a synovial cavity and head of the femur are present, and an apparatus of strong ligaments is attached to the femur, permitting and restraining movements in certain directions. But these movements of the femur are limited, and in two examples the hip-joint was anchylosed without trace of disease. The muscles of these bones may be arranged in four groups, three of which connect them with other parts: (1) Internally with the genital organs; (2) a posterior or caudal mass; (3) an anterior or trunk mass; while the fourth connects the bones to each other.——According to Mr. P. L. Sclater, the wild ass of Somaliland is a new species, or at least subspecies, and is distinguished from that of the Nubian desert by its generally paler and more grayish color, the entire absence of the cross stripe over the shoulders, the very slight indication of the dorsal line, and the numerous black markings on both front and hind legs. It has also smaller ears and a larger and more flowing mane.——Mr. W. Leche (Proc. Zoöl. Soc., 1884) describes some Chiroptera from Australia, including the new species *Nyctinomus petersi* and *N. albidus*. In the latter species the ears are much larger than the head, and are united by a low band.——Mr. J. W. Clark describes (in the Proc. Zoöl. Soc.) a series of stuffed sea-lions belonging to the Australian Museum, Sydney, and from a study of these and other examples concludes that *Otaria cinerea* is " one of the four distinct species of Otaria inhabiting the Australian coast."——M. Fernand Lataste contributes to the Proc. Zoöl. Soc. for 1884, a description of a new species of Meriones, *M. longifrons*, from Arabia, together with a full account of its habits, intelligence and sexual relations. Gestation normally lasts twenty days, and the ovarian period about ten days.

EMBRYOLOGY.[1]

THE ARCHISTOME-THEORY.—The new doctrine of development, of which it is proposed to give a brief and partial sketch here, rests in part on a hypothetical basis and in part upon a well established theory founded upon observation. It consists further in an expansion and adaptation of the gastreal-theory of Haeckel in the light of more recent research, and a reconciliation of it with the deductions of His, Rauber, Whitman and myself, as to the occurrence of concresence of the lips of the blastophore and the differentiation of the axis of the body of the embryo from behind forwards, generally of bilateral types with paired mesoblastic sacks derived

[1] Edited by JOHN A. RYDER, Smithsonian Institution, Washington, D. C.

directly or indirectly from the archenteron. It is also assumed with Sedgwick[1] that the most primitive form in which an imperfect approach towards the differentiation of a body-cavity is evident, as paired pouches of the archenteron, still opening into the latter, is seen in the bilaterally differentiated Actinozoa. It is further assumed that this modification of the archigastrula, as the primitive gastrula may be called as defined by Haeckel, is the first intimation which we have in any existing type, permanently represented in the ascending scale of morphological differentiation of organisms, of the permanent assumption of bilaterality. It is also assumed with Sedgwick that the mouth of such a form was elongated in an antero-posterior direction, thus leading to the differentiation of a permanent mouth and anus at the opposite ends of the original slit-like mouth of such a form. The circumoral band of sensitive tissue is also assumed to have given rise to the median nervous system of Chordata and Achordata. In the former median concrescence of the originally paired cords has been complete, and in the latter incomplete, so as to give rise to circumoral and circumanal nerve rings and a pair of ventral ganglionated cords. It is thus made obvious that I assume in a general way that the hypotheses propounded by Sedgwick are supported by a very large body of evidence and enable us to interpret and reconcile with great readiness the conclusions of biologists in reference to the development of other structures, especially the excretory, generative and appendicular organs. The evolution of the first two, the trachea of insects, the branchiæ of various forms, abdominal pores, muscular somites, etc., has been more or less fully discussed by Sedgwick himself, but the probable source and genesis of the limbs and appendicular organs he has hardly more than alluded to. To this part of the subject and the nature of the gastrula of bilateral forms I shall therefore especially address myself, and I hope greatly expand and further emphasize the views of Balfour's very worthy successor.

The antero-posteriorly elongated primitive gastrula mouth or blastophore of bilateral forms is assumed to have become secondarily elongated, either by a direct and obvious process of median concresence of its lips, as in Clepsine, in fishes, in Peripatus and arthropods generally, or this has become greatly obscured, as in Balanoglossus, Branchiostoma, Chætopoda, Chætognatha and some of the higher chordata and in certain degenerate types, as a result of secondary modifications which have immediately affected the primary sequence of events in the development of the neural plate or medullary groove. I therefore assume, in effect, that the medullary plate in all forms has been primarily formed from the concresced lips of an elongated blastopore, and this has in the

[1] On the origin of Metameric Segmentation and other morphological questions. Studies from the Morph. Laboratory in the University of Cambridge, II, 1884, pt. I, pp. 77-116, pls. x and xi. Also in Quart. Jour. Mic. Science, 1884.

lower forms been very generally perforated in the median line anteriorly to form the permanent mouth, and posteriorly to form the anus. The secondary modifications which have affected this mode of development of the permanent openings into the enteron depend, apparently, in large part upon a change in the aspects of the body, especially in the chordata in which the permanent mouth and anus are both new developments and do not coincide with the mouth and anus of primitive Bilateralia.

The primitively elongated mouth of the larvæ of Bilateralia, with an extended body-axis, or any derived form of the latter, or wherever there is formed a well-defined, unpaired median neural plate, or where a pair of parallel neural plates or cords are developed, I would call the whole area thus embraced an *archistome*. In the higher forms this archistome would be coëxtensive with the neural groove antero-posteriorly, as far forward as the pineal body, and as far backward as the true secondary blastopore, and even beyond it, when a primitive streak was formed by the concresence of the limbs of the blastoderm behind the posterior end of the axis of the embryo. In other words the archistome would extend from the pineal body in chordate embryos along the whole length of the embryonic axis through its blastopore and on through the primitive streak to the point where the yolk-blastopore closed. If the archistome were, therefore, to remain open, it would present the appearance of a cleft dividing the embryo into two symmetrical halves through the median line, and would extend even through the aborted portion of the lips of the primitive blastopore when a very long primitive streak was developed. It is thus rendered evident that I do not regard the unmodified, round gastrula-mouth, as understood by Haeckel, as always representing all of the blastopore in higher forms. According to this view the original gastrula-mouth is in fact greatly elongated as a result of growth in length, in consequence of which bilaterality becomes established, and of which we have the first hint in the Actinozoa. This is further intensified by development from before backwards, since, without exception, the elongate Bilateralia differentiate the cephalic end of the body in advance of the caudal. In confirmation of the foregoing views I would refer the reader to the existing special memoirs on the development of the primitive grooves and blastoderms in the fishes and arthropods (Tracheates especially).

Furthermore, the phylogeny of the mesoblastic somites is absolutely untraceable to any other source except to the gut pouches of a bilateral type approximating the Actinozoa, and whether the process has been abbreviated in arthropods or not, we are at least certain that in some primitive Chordata, the Teleostei, for example, the proof that the mesoblastic somites of the body grow from the concresced lips of the blastopore are so conclusive as to be incontestible. The way in which the mesenteron arises, and

the manner in which the primitive cumulus is formed at the germinal pole of blastodermic vesicle of Arthropoda indicates, it seems to me, taking into account the fact that the mesoblast is split off from the lower side of the neural plate, that the mesoblastic somites are here formed in essentially the same way as in the Chordata. The invagination or folding in of the germinal area, in insect embryos to form the amnion, at first posteriorly and at the sides, or according to the plan just the reverse of what holds in the formation of the amnion in the endocyemate types of Chordata, is to me conclusive proof that concrescence of the lips of the primitive elongated blastopore, or archistome, has taken place; for, in order to effect this sort of an invagination of the embryonic area the head end must for a time remain fixed, while the tail, continuing to grow in length, is thrust into the yolk, as in Calopteryx, carrying the amniotic limb of the blastoderm before it. It also seems that paired cavities soon appear in the mesoblastic somites underlying and derived from the epiblast, as above described in arthropods. I therefore see no very essential difference in the method of development in the two types. In both it is obvious that a portion of the archenteric walls of the elongated archistome has given rise to the mesoblastic somites, by a process which differs in no respect from, but agreeing even in its abbreviation with that which takes place in Branchiostoma directly from the sides of the archenteron.

We now come to the consideration of the most important part of the archistome-theory, namely, that portion of it which deals with the genesis of the limbs and their musculature. The readiness with which the view that the tentacles of an actinozoan ancestral form gave rise to the integument and musculature of the paired limbs of the Bilateralia is reconcilable with all the facts of embryology, is very remarkable. As is well known, the tentacles of Actiniæ consist of an outer layer of epiblast into which a hypoblastic lining is thrust from the paired lateral gut-pouches. If the gut-pouches of the actinian were now shut off from the archenteron we would have mesoblastic somites developed and structures formed which are exactly recapitulated in the development of the Arthropoda. That is, the outer layer in the budding appendages of the embryos of the latter, which grow out from each segment, are constituted of the same two layers, the outer of which gives rise to the hard, chitinous joints, and the inner to the muscles which move them.

In the development of bilaterality through the actinozoa the circle of tentacles would be drawn out into an ellipse, or so as to enclose an oblong space surrounding the archistome. This would bring the primitive appendages, after a free existence had been assumed by the supposed ancestral actinozoan type, into about the position in which they grow out in arthropod embryos around the archistome or furrow in the neural plate. The

post-anal telson or bristles, and the preoral labrum and one or two pairs of antennæ may be supposed to have been derived from a postanal, and a preoral series of tentacles respectively, supposing of course that the mouth is formed from the anterior part of the archistome, while the anus is formed from its posterior portion, while, as supposed by Sedgwick, the middle portion has coalesced.

The biramose legs of Crustacea and certain insects may be supposed to have arisen from a bilateral actinozoan type in which there were two rows of tentacles encircling the oblong archistome. When the inner and outer archipodia of one side, as we may name these primitive limbs, had fused at their bases, we would have a biramose appendage. As the outer layer became chitinized these appendages would become segmented. A very primitive type of limb, which may be supposed to have been derived from the tentacle of an actinozoan ancestry, is found in Peripatus. The parapodia of worms may also be supposed to have been derived from two such circles of archipodia which surrounded the archistome, but which, as the body became elongated, assumed a more and more lateral position. A new set of structures are, however, developed in the parapodia of errant marine worms, the analogues of which are found only in the fin-folds of the embryos of osseous fishes, or as the rays of the most primitive and undegenerate types of adult forms, namely, the Elasmobranchii, Holocephali and Dipnoi. These structures are the setæ which are of epidermal origin in the worms, or at most subepiblastic; as in embryo fishes and in Sagitta. In a former number of this journal I have called these structures in fishes actinotrichia; these are the same as the embryonic fin-rays mentioned by A. Agassiz.

The principal reason why I consider the actinotrichia found in fish embryos analogous if not homologous with the setæ found in the appendages of worms, is the fact that in both cases muscular processes of the mesoblastic somites first become attached to the inner ends of these fine horny or chitinous filaments, which in the worms protrude beyond the margins of the soft tissue of the parapodia, but which in embryo fishes and in Sagitta do not extend beyond the edges of the fin-folds. It is thus rendered obvious that bundles of muscular fibers derived from the muscular somites, developed from lateral gut-pouches, pass outward and are inserted upon the proximal ends of the setæ found in the parapodia of worms as well as the actinotrichia found in the fin-folds of fish embryos. In fishes these muscular processes are given off to the actinotrichia of the unpaired as well as to those of the paired fins. These muscular processes moreover pass outward into epiblastic folds in both cases metamerically or from each segment. In the worm to a bunch of setæ in a single parapodium, in the fish to a bunch or longitudinal series of actino-

trichia to the number of a dozen or so opposite each segment. In fish embryos the actinotrichia finally have their proximal ends drawn together out of their original parallel position under the epiblast of the fin-fold, and radiate more or less markedly from the point where the muscular process from the mesoblastic somite is inserted upon them, the same as the diverging setæ in the parapodia of worms. This divergency gives rise to the dichotomous character of the bony rays of Teleost fishes, since, as I have shown in a previous article, the actinotrichia are the rudiments of the permanent osseous, segmented rays of the malacopterygian type. For these reasons I am very strongly inclined to believe that the parapodia of worms and the fin-folds of fishes are very intimately and probably genetically allied to each other.

Another strong reason for such a belief is that in Sagitta in which the transverse septa in the body-cavity have been obliterated, as in Chordata, the setæ are found, as in fish embryos, lying parallel with each other and in horizontal, lateral, continuous fin-folds. This would seem to indicate that Sagitta had descended from a worm in which a lateral row of parapodia had gradually become fused together serially by their edges so as to form a more or less nearly continuous lateral fold. And I see no reason to doubt that a similar longitudinal or serial concrescence of primitively distinct metameric finlets may have occurred in the Protochordata, and given rise to the median and lateral longitudinal fold from which all of the fins develop. The next strong reason for this conclusion is that an actual longitudinal concrescence of the metameric elements of the paired and unpaired fins of fishes actually occurs. This is especially obvious to any one who has studied the mode of development of the fins of fishes in which extensive longitudinal concrescence has taken place, and of which any one who will examine an adult skate may easily satisfy himself. In this form the pelvic and pectoral pairs of fins have been formed of a primitively continuous series of metameric elements, as shown by the development. The anterior part of the lateral series of metameric elements of the fin-fold in this type are crowded together at their bases to form a pectoral, the posterior part of the series of elements are in the same manner crowded together to form the pelvic fin. In this way it comes about that the rays and metameric elements lose their original parallel position with respect to each other and become divergent distally, while the basal parts of the skeletal series of elements concresce or fuse to form the compound pro-meso and metapterygial pieces.

The lateral fins of fishes I regard as having arisen from the serially fused notopodial appendages of a worm-like ancestor, the unpaired fins in like manner I regard as having arisen from parapodia; the dorsal median fold from the two lateral rows of neuropodia which have concresced on the median line, and the ventral fold from the two rows of notopodia which have in like

manner fused together on the median line serially and transversely. The actinotrichia of all the fins are accordingly represented ancestrally in the slender embedded part of the parapodial setæ of worms.

These conclusions seem to support those of Dohrn, but also receive additional support from a consideration of the segmental organ and the way these are developed in certain worms, according to Hatschek, and in Chordata, according to Semper and Balfour. In one other important point the primitive Chordata and chætopods agree, namely, in the possession of a great number of segments or mesoblastic somites. I therefore regard the Chordata and Chætopoda as representing two divergent series. The former, upon the concentration of the muscular substance of the somites on the neural aspect of the body-cavity, and the abortion of the latter in the caudal region, acquired a new mode of progression, the tail then became vertically flattened, so that the parapodia were thrown into two rows dorsally and ventrally, and finally fused as supposed above; the displacment towards the middle line of the rows of parapodia being greatly favored by the lateral movements of the tail of the ancestral form. The presence of the body-cavity and viscera anteriorly probably prevented the shifting and median concrescence of the notopodia, so that they remain near their original position as the rudiments of the paired fins.

These views may at first seem far-fetched and improbable, but when I am able to present them more fully with new data and illustrations in a special memoir[1] upon which I am now engaged, I hope to be able to show that they lead to conclusions of the greatest possible moment in scientific morphology.—*John A. Ryder.*

PHYSIOLOGY.[2]

MEDICAL PHYSICS.[3]—The time has come when even in America it is recognized that medical education demands for a foundation a knowledge of those general chemical and physical laws which control the history of matter in all its forms. In Germany and France special courses in physics have long formed a part of the medical curriculum, and Dr. Draper has undertaken the difficult but praiseworthy task of preparing for the English-speaking medical student a non-mathematical text-book of physics which shall present with tolerable completeness an account of matter and its laws, with special reference to their bearing on the physiological processes of the body. There are probably few scientific subjects in which the selection of material and the method of

[1] Studies on the development of the Chordata and Achordata, together with an exposition of the Archistome-theory.

[2] This department is edited by Professor HENRY SEWALL, of Ann Arbor, Michigan.

[3] By J. C. Draper, M.D., LL.D. Lea Bros. & Co., 1885.